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(54) Safety device for electric immersion heater

(57) A safety device for an electric immersion heater comprises a short section of a low melting temperature metal fuse surrounded by a low disintegration temperature insulator (7) and incorporated into a resistor element (3) of the electric heater (1) so as to ensure that the moment the electric heater (1) is not immersed in liquid the electric heater (1) will cease functioning since the metal fuse melts, the melted metal flowing into a space left when the insulator (7) disintegrated as the temperature rose.

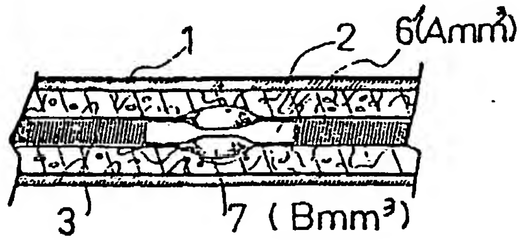

Fig. 5

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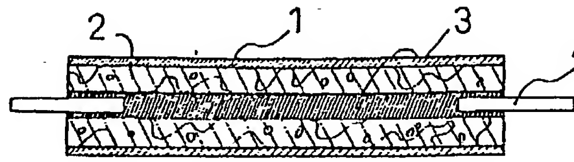

Fig. 1 Prior Art

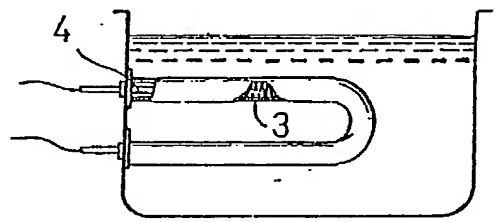

Fig. 2-2 Prior Art

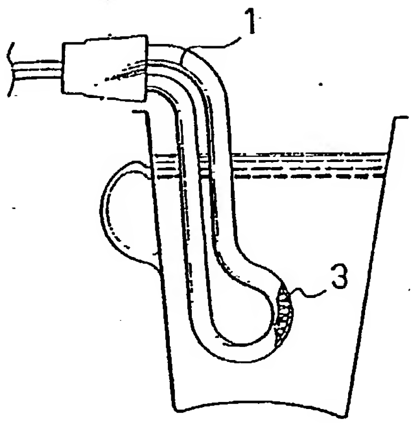

Fig. 2-1 Prior Art

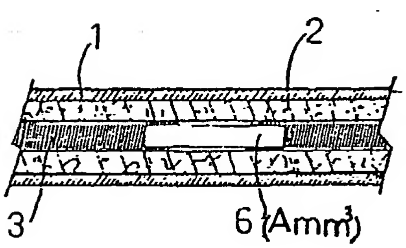

Fig. 3

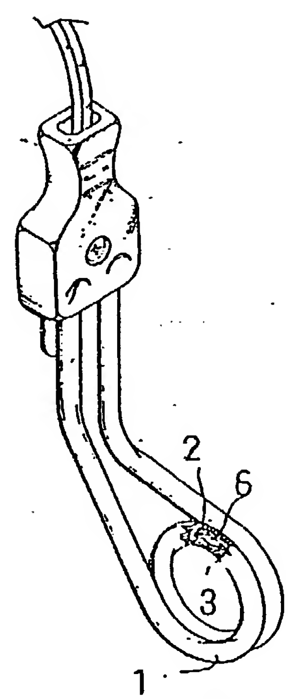

Fig. 4

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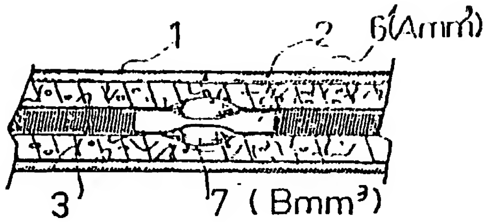

Fig. 5

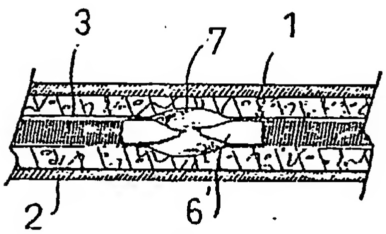

Fig. 6

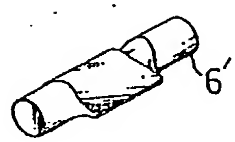

Fig. 7

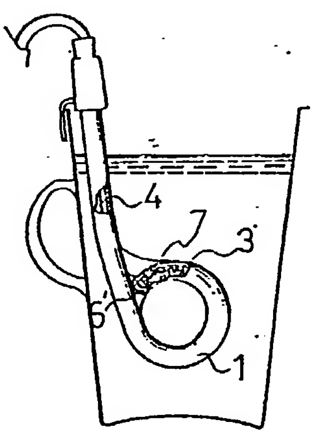

Fig. 8-1

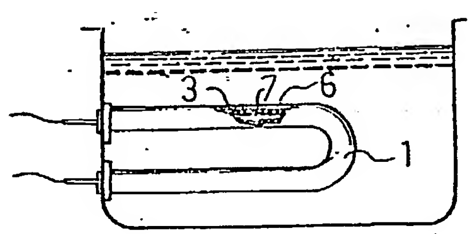

Fig. 8-2

SPECIFICATION

Safety device for immersion electric heater

This invention is concerned with a built-in safety device for the immersion type of electric heater particularly with a low-temperature metal fuse wrapped by a low-temperature coating material and incorporated into the resistor element of the immersion type of electric heater for ensuring safe heating operations.

Conventionally, the immersion type of electric heaters as shown in Figs. 1 through 2–2 are usually constructed that the resistor element 3 is systematically combined with the terminal post 4 located at the center of the protective metal tubing 1 into which an insulating material 2 of magnesium oxide is stuffed around the heating resistor therein, and then pressed by the compressor so as to increase the density of the insulating material and its heat-conductivity as well. This is normally how a straight type of electric heater is made. In cases where various heater shapes are required to suit different applications, it is necessary to further process the heater in a curved profile such as those can be immersed into water or some other kind of liquid for heat treatment.

The resistor element used in the conventional immersion electric heater has a minimum fusion point more than 1400°C whereas the minimum safety using temperature is 1100°C. This means that the breakdown condition for an immersion electric heater can be reached only if the temperature of the resistor element if over 1100°C. In other words, the immersion electric heater can allow its surface to reach a thermal state as high as 1000°C or higher when it is used in naked state in the air (the balance of 100°C is the temperature loss in the resistor element). Under such a high temperature, contact by any practical substance will bring about a fire accident or burn through cauterization. Therefore, any casual carelessness in using such elecric heater will certainly result in unexpected disasters. On the other hand, as the immersion electric heater is generally used for heating water which, under ordinary pressure, the maximum boiling point is 100°C. In this case, the highest temperature that the immersion heater will run in the water is also 100°C. Meanwhile, owing to the heat conduction of the insulating magnesium oxide stuffed in the tubing of the immersion electric heater, a difference of 100°C in temperature between the interior and the exterior of the heater exixts. For this reason, the heating temperature of the resistor in the tubing will not exceed 200°C. Such a difference in temperature is too low in comparison with the minimum using temperatur 1100°C of the resistor therein. Therefore, it is dangerous when such a heater is exposed in the air during heating operations.

Concerning the manner of installation, two types of immersion heaters are most commonly found on the market, namely (1) a mobile type which can be taken for use in any vessel as desired such as that called "electric spoon," and (2) a fixed type such as those fixedly installed on the electric teapot, the electrical percolator, and the electric water oven. However, the defect of both types mentioned above is that no safety device is provided thereof for preventing contingent accidents as in the cases that when the immersion heater is in operation where children are playing near by or the attendance of the grown-up is absent, the heater often becomes exposed to the air in naked state, and the surface temperature of the heater increases rapidly to such a degree as to be susceptible to injure human body through contact, or to become a potential danger for imminent fire accident. Comprehending such problems, most advanced industrial countries have established the safety usage standards for the electric heater. Among the standards are the C.N.S. of Taiwan, the U.L. of the United States, the J.I.S. of Japan, the V.D.E. of West Germany, the B.S. of United Kingdom, etc. All of these standards call for the providing of an automatic temperature control or overheat cut-off protecting device or other similar one like safety means to all of the electric heaters in daily use. However, such extraneous safety device will incur trouble such as inconveniences in production, in assembling procedures as a result of bulky volume, non-uniformity in quality and in handling of the product once they are applied on the immersion type of electric heaters.

The present invention is presented for eliminating all the shortcomings as mentioned above, and providing a built-in safety device for the immersion type of electric heater so as to obviate potential dangers and ensure a lasting security for the users. Furthermore, it reduces the manufacturing costs in great proportions up to some ten-folds in terms of production costs for safety means. Besides, this invention is consistent with such essential principles as simplicity, economization, safety and usefulness.

The primary object of this invention is to provide a novel and built-in safety device for the immersion type of electric heater to prevent the users from being injured through cauterization of the heater and to avoid potential danger resulting from high temperature thereof.

Another object of this invention is to provide a simple built-in safety device for the immersion type of electric heater by eliminating the inconvenience of extraneous safety means as being conventionally provided in the prior art. As a result, manufacturing costs are

greatly reduced.

The safety device as covered by the invention is to have a small piece of low-temperature metal fuse incorporated into the central portion of the resistor being provided in the immersion electric heater, and the periphery of the metal fuse is wrapped with suitable low-temperature insulator such as silicone rubber. Once the resistor of the immersion electric heater is constructed with the safety device as covered by the invention and put to use in the liquid required for heating, it will have a inner temperature up to 200°C which is lower than the fusion point of the low-pemperature metal fuse selected with a predetermined fusion point of 280°C. Therefore, it will keep the heater intact from overheating demage within the temperature of its fusion point. Meanwhile, if in occasions when the immersion electric heater incorporated with the invention leaves the surface level of the liquid in heat-processing, and presents itself in naked state, the temperature of the resistor in the immersion heater will instantly rise up, and by the time it reaches the temperature of 280°C, the low-temperature metal fuse built in the middle portion of the resistor will melt open instantaneously, cut off the power source, stop heating, and repress the upsurging of the surface temperature of the immersion heater so that the surface temperature of the heater will soon drop down and become cold. Under such condition, there can hardly ever come into being any cauterizing injury or fire accidents.

The fundamental characteristics of the invention lie in that a coating of a suitable quanitity of low-temperature insulator such as silicone rubber is applied over the periphery of the low-temperature metal fuse built in the resistor of the immersion heater, and the maximum thermal endurance of the coated insulator is 250°C. As the temperature of the resistor goes up, the low-temperature metal fuse will get a high temperature making the coated insulator become heated and broken up to cinder at the moment the temperature of 250°C is reached thereat. In this case, the cindered insulator will leave a space therein as big as the volume of the coated insulator itself. Furthermore, when the temperature of the resistor continue to run up to 280°C, the low-temperature metal fuse will become melted and flowing to the space left over by the coated insulator, resulting in the breakdown of the metal fuse and cut off the power source thereby ensuring the safety of usage.

Supposing no low-temperature insulator coated over the periphery of the metal fuse, despite that the temperature of the resistor has risen to the fusion point of 280°C, and that the metal fuse has been melted, there would not be a suitable space available for the flowing movement of the melted fuse because the magnesium oxide material stuffed in the tubing has a fusion point more than 1500°C, and would not melt out a space at a temperature as low as 280°C, so that even the metal fuse is melted therein, it would not break down to cut off the power source. As a result, the temperature of the resistor will continue to rise to a dangerous condition until the stuffed magnesium oxide is melted therein. Therefore, it is clear that without a low-temperature insulator coating over the periphery of the metal fuse, the safety feature cannot be achieved.

The temperature figures heretofore presented are theoretical figures for facilitating explanation of the invention. For practical applications, designs may be worked out according to particular specifications. It is often the case that the temperature figures are not so important. What is essential is that the theory and the outcome of the actual experiments can exactly establish the safety principle and justify it withal. To quote the safety rule stipulated in the U.L. standards of the U.S.A. as a reference, "The household immersion type of electric heater, while leaving the surface level of the liquid and getting exposed in the naked state to diffuse heat, shall automatically have the power source cut off and stop heat diffusion within 20 seconds at the power rate of 500 watts; in the meantime, the toilet tissue covering thereon shall not catch on fire and get burnt." So it is clear that the exact values of the relevant temperatures are not as important as the principle to ensure a safe use of the device in question under most hazardous operative conditions. This is what really matters. It can be further reasoned that compliance with a given safety standard can impossibly be determined by the method of theoretic design or a specific figure data coming out of instrumental testings. It will have to be dealt with experimentations performed undet different approaches and practical conditions so as to get the results. The safety standards that are desired should be selected among such useful results thus obtained that can best conform to the prescribed safety levels.

There will now be described examples of the safety device according to the present invention. It will be understood that the description, which is to be read with reference to the drawings, is given by way of example only and not by way of limitation. In the drawings:—

Figure 1 is a longitudinal sectional view of the resistor and tubing structure of an ordinary electric heater,

Figure 2—1 is an illustrative representation of the ordinary mobile and immersion type of electric heater in use,

Figure 2—2 is an illustrative representation of the ordinary fixed and immersion type of electric heater in use,

Figure 3 is a longitudinal sectional view of an electric heater incorporated only with a

low-temperature metal fuse,

Figure 4 is a perspective view of a mobile type of electric heater incorporated with this invention,

Figure 5 is a longitudinal sectional view of the safety device of this invention,

Figure 6 is a sectional view of the safety device of this invention showing the low-temperature metal fuse being melted open,

Figure 7 is a perspective view of the safety device of this invention showing the central portion of the low-temperature metal fuse being flattened for increasing its resistance and melting efficiency,

Figure 8–1 is an illustrative representation of this invention incorporated with a mobile and immersion type of electric heater in use, and

Figure 8–2 is another illustrative representation of this invention incorporated with a fixed and immersion type of electric heater in use.

Fig. 1 through Fig. 2–2 are the structure and applications of the conventional electric heater as described in the preceding paragraphs. In order to accomplish a definite built-in safety device as hereunder presented for the invention, numerous trials and tests have been conducted before a successful outcome is achieved. We have found, for instance, that if only a low-temperature metal fuse 6 is incorporated into the resistor 3 as shown in Fig. 3 and 4, the function of an expeditious breakdown as to cut off the power source the moment the heater is exposed to the air in a naked state couldn't be fulfilled, and the safety feature would be a failure. The reason is that suppose the volume of the low-temperature metal fuse 6 is A mm^3 and the normal operative temperature of the heater 1 is exceeded, the metal fuse 6 will certainly be melted, but the melting part is still confined in the high-density powder of the magnesium oxide stuffed in the tubing 1 with its volume remaining at A mm^3 resulting in the alive of the power source thereof. Experiments successfully concluded that if a part of the low-temperature metal fuse 6' is wrapped by a low-temperature coating material 7 such as silicone rubber as shown in Fig. 5, an area occupied by the coating insulator 7 is B mm^3, so that the space the metal fuse 6' being wrapped by the coating insulator 7 in the magnesium oxide 2 is A mm^3 plus B mm^3. Whenever the heater 1 is in overheat condition, the coating insulator or silicone rubber 7 wrapped over the low-temperature metal fuse 6' will get burned into cinders, thus emptying the area B mm^3 it had occupied, so that sufficient space will be available for the metal fuse 6' to be melted open thereat so as to completely cut off the power source in time and maintain the circuit in safe condition as shown in Fig. 6.

Furthermore, in order to increase the resistance of the low-temperature metal fuse 6' and its melting efficiency the central part of the metal fuse 6' is preferably flattened as shown in Fig. 7.

Applications of this invention are shown in Fig. 8–1 and 8–2 wherein the mobile type and the fixed type of the immersion heaters are respectively incorporated with the safety device of this invention.

Materials selected through many tests for the invention are: (1) material for the low-temperature metal fuse 6' is a kind of metal with a lower fusion point, lower cost and easier to obtain, e.g. tin, lead, and moderate tin-lead alloy, and (2) silicone rubber is the most desirable substance to be used for coating the metal fuse 6'. P.V.C., rubber, paper, clothe, and fabric material can also serve the purpose of coating over the metal fuse 6', but not desirable.

From the experiments made for the invention, it is found that both the immersion heater incorporated with the safety device of this invention and the ordinary immersion heater not equiped with safety means have the same lifespan of usage. The findings of the experiments also indicate that (1) quantity of the coated silicone rubber should be applied in such a way as to enable the low-temperature metal fuse to get melted open; (2) the dimension of the cross-section area of the low-temperature metal fuse is in direct proportion to the time required for melting, that is to say, the larger the cross-section area of the low-temperature metal fuse, the longer the time required for the melting to take place; and (3) when the immersion heater incorporated with the safety device of this invention is heated in naked state, its heat diffusion per unit area will be in inverse proportion to the melting time of the low-temperature metal fuse, that is to say, a greater heat diffusion per unit will result in a shorter time in which the melting takes place.

Details taken from the experiments for the melting time of the low-temperature metal fuse when the heater is used in naked state are recorded as follows:

From power on to breakdown, the melting time takes–

14 seconds at 16.1 watts per square centimetre (cm2)
14 seconds at 15.8 watts per cm^2,
17 seconds at 11.8 watts per cm^2,
20 seconds at 10.7 watts per cm^2,
25 seconds at 8.2 watts per cm^2,
27 seconds at 6.0 watts per cm^2,
45 seconds at 4.5 watts per cm^2,
60 seconds at 3.5 watts per cm^2, and
143 seconds at 3.0 watts per cm^2.

The tests are also conducted under the condition that toilet tissue is folded over the periphery of the electric heater incorporated with the invention, and no any of the tissue has been burned thereat.

From the testings performed, a certain criteria can be set up as the specific safety standard of this invention so as to comply with a given established safety standard as specified by a certain nation or a particular organization. This can be done easily and accurately. For instance, if it is desired to meet the safety standard set by the U.L. of the United States as mentioned above, we can set out a specification for manufacturing the electric heater with the safety device incorporated therein simply by following the standard of the unit area heating-diffusion rate like the records listed above, e.g. 10.7 watts per cm^2 will make the melting process last in less than 20 seconds throughout the naked heating state.

CLAIMS

1. A safety device for immersion type of electric heater comprising a short piece of low-temperature metal fuse incorporated midway on a resistor element of said immersion heater, and a low-temperature insulating material such as silicone rubber coated over the periphery of said metal fuse for leaving a space thereat on being cindered by overheating beyond given temperature range so as to allow the flowing of the melted part of said metal fuse when specified temperature of heating is reached, whereby said immersion heater in use can effectively cease functioning by timely breaking down said metal fuse and cutting off the power source thereof the moment the immersion heater in use being separated from the liquid or the surface of the liquid being heat-treated reached at a point where said immersion heater is exposed to the air in a naked state resulting in high temperature, thus ensuring no any danger of posing cauterizing injury to human body or causing fire accidents thereby.

2. A safety device for immersion type of electric heater as claimed in Claim 1 wherein a portion of said low-temperature metal fuse is processed in a shape like a flat surface so as to increase its resistance and enhance melting efficiency thereat.

3. A safety device for immersion type of electric heater, constructed and arranged substantially as hereinbefore described with reference to and as shown in
(a) Figs. 5, 6, and 7;
(b) Figs.8–1 and 8–2
of the accompanying drawings.

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